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FOREST SERVICE
U.S.DEPARTMENT OF AGRICULTURE
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IMPACT in California and Colorado: applications of a computer system before it was complete

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Research Note PSW-336
March 1979

Thor, Edward C., Richard C. Smardon, and Richard Adams.
1979. **IMPACT in California and Colorado: applications of a computer system before it was complete.** Res. Note PSW-336, 7 p., illus. Pacific Southwest Forest and Range Exp. Stn., Forest Serv., U.S. Dep. Agric., Berkeley, Calif.

IMPACT is a computerized environmental assessment system recently developed by the U.S. Forest Service to ease the work of land-management agencies in environmental impact assessment. The system consists of an information base and an interactive computer program. The information base includes literature references to aid in analyzing specific environmental effects. As IMPACT was being developed, it was applied to two field problems, one in California, and one in Colorado. Application to real life problems before the system was complete, rather than waiting until after completion and formal evaluation, proved effective in steering the course of development for IMPACT to meet management needs. IMPACT is currently being used by offices of both the Forest Service and the Bureau of Land Management.

Retrieval Terms: environmental planning; recreation area planning; planning area guides; computer programs; IMPACT (computer program).

IMPACT is a computerized environmental information system to aid forest and rangeland managers with the difficult tasks of assessing environmental impacts and of preparing impact statements.[1,2] The system uses an information base of short-phrase descriptions of a variety of management activities and effects of these activities linked together in cause-and-effect relationships. The information base also includes comments and literature references useful in analyzing specific environmental effects.

Before IMPACT was fully developed it was already being applied in conjunction with existing Forest Service land-management decision processes. Participation in actual management situations early in the development of computerized systems is part of a development strategy which we believe is necessary to assure that once researchers have developed a system, it will not only be complete, but will also be tuned to management needs.

Two pilot field applications of IMPACT took place—one in California, and the other in Colorado. This note describes these applications at the Tahoe National Forest, California, in the evaluation of a ski area, and in Colorado, in the preparation of several area guides for the Rocky Mountain Region and the Northern Great Plains.

IMPACT: HOW IT WORKS

IMPACT's data base aids environmental impact assessment efforts in a number of ways. By providing guidance as to *what* to examine, the manager, in his

preplanning and selection of the team, and the team members can use the system to examine an accumulation of past experience and research results indicating what effects occur with different activities. Through the interaction of man—who knows the local proposals and situation—and the machine—which provides general guidance and accumulated information—the *what* results can be tailored to each specific situation. IMPACT indicates the relationships among different effects and thereby provides *structure* to the assessment. It provides each specialist with a cause-and-effect framework for guiding his studies. The network of interrelationships examined through IMPACT indicates to the specialist the other specialists with whom he should cooperate, and provides guidance to the team leader or manager for coordinating the work of many specialists. By providing highly selected literature references, IMPACT tells specialists *where to look* to increase their understanding of particular relationships, to find quantitative research results relevant to their studies, or to find methods and models which the specialists can use to develop their own quantitative impact predictions. Finally, by allowing users to contribute to a centralized file, IMPACT can capture the results of an assessment for later use in similar situations.

The IMPACT user sits at a remote computer terminal and asks special English language questions which examine the information base. The user builds on the answers to previous questions, adapts the responses to local situations, isolates relevant portions of the information base, and then examines these portions in detail. The examination process frequently will require extensive study away from the computer, where the user digests and refines the information provided by the system, follows its guidance, answers the questions raised by the system, and develops further questions to ask IMPACT.

IMPACT is an unusual computer system. It is entirely qualitative; it does not use local data to calculate final answers. Instead of *final* answers, IMPACT provides guidance and raises questions. Unlike traditional information retrieval systems which are consulted once to see what they contain on a subject, IMPACT is used repeatedly to examine the same information in a number of ways and at different levels of detail, while the information is still in the computer. This unusual approach is necessitated both by the enormous scope of the information, and by the importance of the *structure* of cause-and-effect relationships, which cannot be represented adequately in a computer printout or chart.

It took a number of years to develop IMPACT. During this development, long before it could be judged complete or fully operational, two pilot field applications were undertaken to aid in the development of the system.

FIELD APPLICATIONS BEFORE A SYSTEM IS COMPLETE

Field applications of a computerized system usually occur *after* the system is complete. Researchers conceive a system; determine the need for such a system; develop the system to meet this need; and after the system is complete they conduct one or more pilot field studies. These applications demonstrate the use and usefulness of a system, and allow potential users to conduct their own evaluation before committing themselves. One form of this process is illustrated in a Regional supplement to the Forest Service Manual (*fig. 1*).

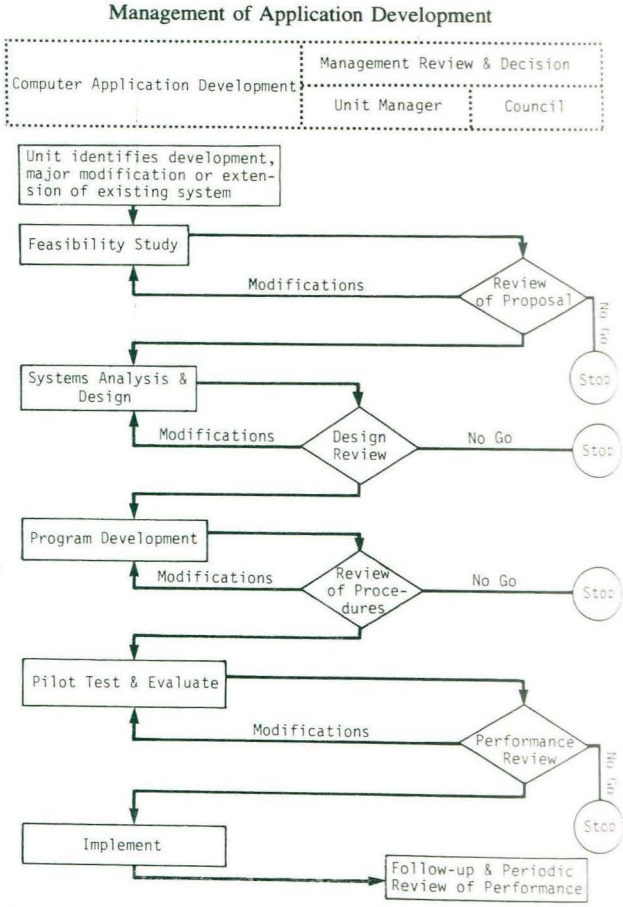

Figure 1—Process for management of application development.

We believe this approach to systems development is wrong. It can lead to the development of systems not suited to the needs of management, decreased acceptability of these systems to management, and wasted efforts by researchers. Perhaps worst of all, the loss to management of potentially useful systems through insufficient coordination and communication can result. Under the standard development approach the evaluation accompanying field applications takes place after development is complete. The evaluation is in terms of, "Does this system meet our needs?" The answer will be either "Yes" or "No." If it is yes, then all is well. But if the answer is "No," the system does not meet the needs, then it is often too late to do anything about it–except to discard the system. This happens entirely too often.

There are reasons why systems developed in these circumstances do not meet user needs. The needs, which all but the simplest computer systems address, are often complex and difficult to define. Even where managers and researchers jointly agree on the needs, their different perspectives can lead to different perceptions of the needs. Mere discussions may not clarify these different perceptions. Similarly, it is difficult for potential users to verbalize accurately the management situation, timing requirements, and the availability of expertise, data, and equipment. The researcher has the same problem verbalizing what he can and cannot do, and what he expects from the user. For these reasons, the first application of any computerized system to an actual, full-scale management situation will often surface a need for significant modifications in that system. If this first application occurs only after development is complete and the system has been finalized, it can be too late to make the necessary modifications. The costs in time, effort, and money to go back to a much earlier stage in development may be just too high. The researcher and the user may become adversaries, each insisting the other should change.

The problem is avoided if the first field application occurs as soon as practical during the development of a system. Evaluation *during* systems development can lead to improved and more useful systems. Instead of "talking about" the system and about the situation, both the researcher and the manager can *experience* the system operating in the context of management situations. When needed modifications surface, they can be made before the system becomes locked in.

Early field applications have other advantages. The user can offer his criticisms and suggestions less judgmentally, and the researcher can accept them without needing to defend the system. When the user sees his suggestions incorporated into the final system his sense of ownership and responsibility for the system can further acceptance of the completed system. The user then more readily recommends the system to his colleagues–and with justification–for he knows it has been adapted to their needs. The user benefits, because he is allowed to use the system before it is generally available. The researcher benefits by having his system improved. Both the manager and the researcher benefit from the working, rather than judgmental, relationship which they can apply to future management and research problems.

THE CALIFORNIA EXPERIENCE

Background

Early in 1976 it became apparent that the Walt Disney Corporation would submit a request for a special use permit and land exchange proposal for developing a major year-round recreation resort at Independence Lake, a few miles north of Truckee, California, in the Tahoe National Forest (*fig. 2*). Along with this proposal the Disney Corporation had prepared a 1000-page environmental document. The

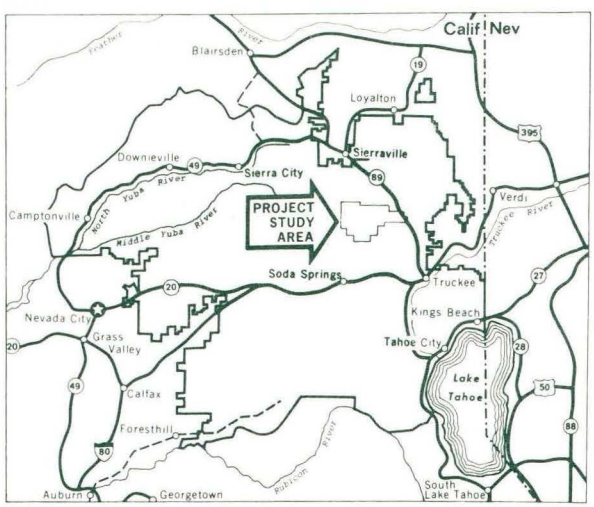

Figure 2—The IMPACT system was used to help evaluate a proposal to develop a ski resort at Independence Lake, north of Lake Tahoe.

initial Forest Service task was to assess this document to determine what additional information would be necessary to evaluate the proposal in compliance with the National Environmental Policy Act of 1969 for the Forest Service and the California Environmental Quality Act for the county government. As part of an agreement between the California Region, the Forest, and the Pacific Southwest Forest and Range Experiment Station, the developing IMPACT system was used for this evaluation. At this time, IMPACT was very much an incomplete system.

The interdisciplinary team conducting the review of the Disney Corporation documentation consisted of a team leader and 26 specialists from the District, Forest, and Regional Offices. Members of the team were encouraged to use IMPACT, but then were given free choice as to the degree with which they used it.

Results—The Researcher's Viewpoint

The Tahoe National Forest IMPACT application, the first one undertaken, provided information about the use, the program, and the information base at an early enough stage so that modifications to the program were easily made.

Applying IMPACT to a real problem at this early stage helped the system to develop in a number of ways. First, it clarified *who* should use the system and actually type the requests into the computer. From the beginning, IMPACT was designed to be used directly by specialists and managers without a computer background. During this first application, IMPACT was used independently by the team leader, independently by the computer specialist attempting to provide information to other specialists, and at all levels of joint effort by the computer specialist and environmental impact specialists. The experience indicated that the system worked best with high involvement of the environmental impact assessment specialist, regardless of his or her computer background. It was difficult for the computer specialist to fully understand each environmental specialist's needs—when these were often unclear even to the environmental specialists at the beginning of computer sessions—and then identify relevant portions of the information base. This fact resulted in additional efforts to make the program easy to use, and to prepare user instructions and documentation that do not assume previous knowledge of computers.

Secondly, the application was helpful in clarifying *how* IMPACT should be used. Before this application experience, researchers knew how to manipulate the system, but had only a general understanding of how it could be used throughout the planning and environmental impact assessment processes. On any system where the user and computer interact, knowing how to use the system to accomplish the user's purpose is much more complicated than merely knowing the format of the individual user inputs. The increased understanding which resulted from the pilot application heavily influenced the direction of the system's development, and aids on how to use the system were incorporated into training and user instructions.

The experience also resulted in modifications in the computer program to make the system more usable. Some existing features were modified and additional features were developed in response to expressed needs. The form and content of the computer answers to standard questions, for example, were completely revised, based on user responses. Some features which had been optional were made standard, to avoid having to ask for them every time. IMPACT was initially designed to print any one of three levels of detail in response to questions. This field application indicated the need for each user to be able to specify his own level of detail in addition to the standard responses. A new feature to do this was added. Additionally, observing which features were used most often in a real situation, how these features were used, and which were seldom, if ever used, led to an understanding of how to make the final computer program more efficient.

Finally, exposing the information base to a variety of practicing specialists while it was still in a state of flux allowed us to discover the types of information most needed in the field. This exposure indicated priorities for filling gaps in the information base. We found, for example, that the social and economic relationships and consequences of environmental effects were the weakest parts of the information base and the areas for which field personnel needed the most help. A cooperative agreement was made between the Experiment Station and the University of California at Berkeley to develop this information for us. This early exposure further provided the experience we needed before undertaking the necessary but time-consuming step of completely reworking the existing information base which had developed under evolving guidelines. The information base was made consistent, a new keywording system was developed to facilitate access to the information base, and a new method of identifying literature by geographical and ecological regions was added.

Thus, in a number of ways IMPACT was improved by this early application. The experience provided guidance for additional development changes to make

the system more useful and these changes were easily made. But what about the field personnel? Was it to their advantage to participate in an unfinished system?

Results–The Manager's Viewpoint

The supervisor of the Tahoe National Forest[3] and the project interdisciplinary team leader were approached and asked if they would be willing to use IMPACT while it was still in the developmental stage. Initially, one of the main concerns of Forest personnel was that they did not want to devote time to something that was not beneficial to the Forest in the immediate future, even though IMPACT might develop into a beneficial tool for use later on. This concern was based on limited time and money to complete the immediate task at hand, the analysis of the proposed Disney Project. After reviewing IMPACT and what it is designed to do, however, the Forest supervisor and team leader decided that although incomplete, IMPACT was far enough along in its development to be useful.

IMPACT was presented at an interdisciplinary team meeting, and the team was asked if any specialists wanted to participate in using and evaluating IMPACT. Several did, and arrangements were made either for additional training so they could use the program on their own, or for work sessions to use the program assisted by the developers. In addition to specialist usage, the team leader was interested in using IMPACT for an overall assessment of the project proposal.

The specialists used IMPACT to explore interrelationships in very specific areas and to obtain literature references to support their findings. Feedback from the specialists was favorable. They felt they received literature references and much useful information which would aid them in evaluating the project proposal. Certain areas of the information base were incomplete, and these deficiencies were pointed out.

The team leader used IMPACT in an entirely different role. His purpose was to coordinate the team of specialists, and to personally evaluate Disney's 1000-page environmental document in its overall context to see if all major subjects required in a Federal environmental impact statement were included. IMPACT proved useful in obtaining this overview and in evaluating the adequacy of the Disney document. With IMPACT, a better overall picture of the many cause-and-effect relationships associated with ski area development could be visualized.

During this process it was discovered that IMPACT could be used to perform other functions not considered previously. By looking at the many interrelationships associated with a ski area as displayed by IMPACT and the specific proposal, for example, a project manager can determine many of the specialists who will be needed to supply information during the preparation of an environmental impact statement. At the same time, limitations in both the program and information base were discovered and discussed with the researchers. Removing these limitations resulted in making IMPACT a much more powerful tool.

The Tahoe National Forest found IMPACT to be a useful tool even at this stage of development. The program itself was found to be relatively easy to use with little previous training in computer usage. The users felt that IMPACT was most effective when the team leader or a specialist worked alone, unaided by computer specialists in a series of short computer sessions separated by periods of study of the information obtained from IMPACT.

THE COLORADO EXPERIENCE

Background

In spring 1977, about 1 year after the Tahoe National Forest application, the developing IMPACT system was again used in an actual field problem. Under a tight timetable, staff members in the Forest Service's Rocky Mountain Region were preparing three preliminary area guides simultaneously.[4] These area guides and a Regional Summary would constitute a broad planning document for Forest Service activities in the eastern part of the Rocky Mountains, an area spanning six States (*fig. 3*). This effort was one of two national pilot projects in area guide development resulting from the National Area Guide Task Force.

IMPACT was used during this effort, but not as planned. At a preliminary meeting in Denver, the system was presented to the Region's staff systems coordinator and a resource analyst.[5] The presentation included a short "hands on" training session during which a general checklist of social and economic impacts was prepared to be used by several consultants assisting with the area guide work. At the end of the presentation it was agreed IMPACT would be used in the area guide preparation as soon as the key issues to be discussed in the area guides were identified, and that training and assistance were to be provided.

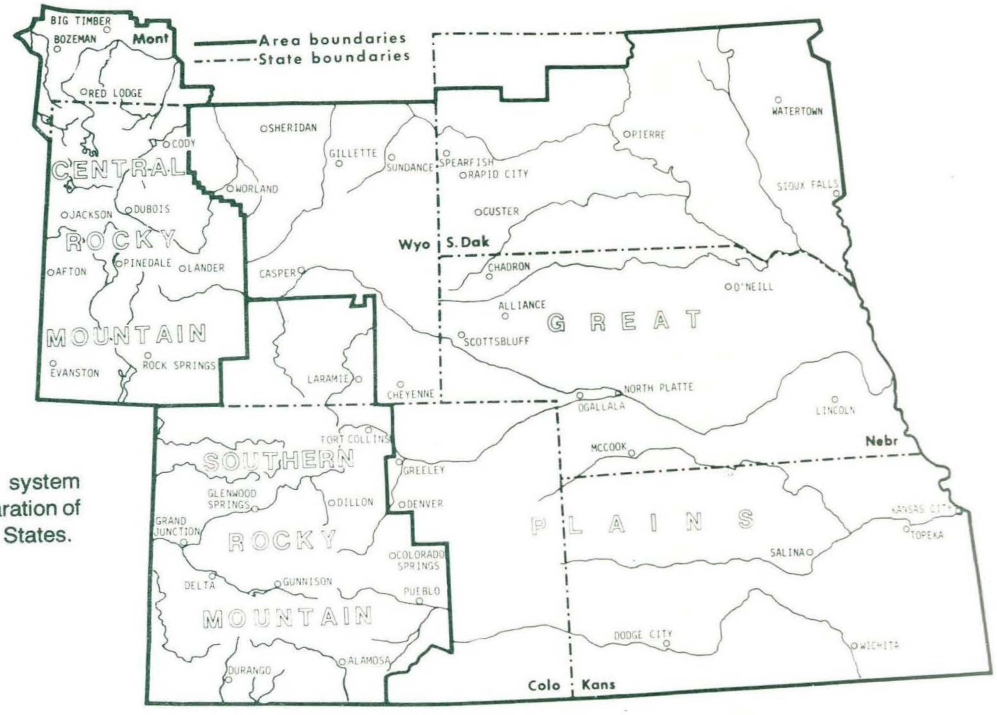

Figure 3—The IMPACT system was used during the preparation of area guides spanning six States.

The agreement, as written, was never carried out, as a result of problems totally unrelated to IMPACT. Difficulties in the early phases of the work delayed the time for which IMPACT was to be used until just a few weeks before the final deadline. This delay resulted in several weeks of working night and day, and in final products of a more preliminary nature than first anticipated. There just was not time to coordinate assistance in using IMPACT.

The resource analyst, who had had a general introduction to IMPACT and about 2 hours of individualized training, however, used IMPACT extensively during these last weeks. He initally used the system to stimulate thinking about potential impacts related to the major issues and to suggest types of data and expertise needed to assess these issues. One of the issues discussed was the amount and general location of downhill skiing to be provided on National Forest land in the southern Rocky Mountains. This issue would be influenced not only by the demand for skiing and the physical availability of slopes, but also by the social, economic, physical, and biological impacts resulting from building ski areas. IMPACT was primarily used to identify the impacts of activities associated with these issues and to search for impacts which were common to a number of the key issues. This material was included in the preparation of a "direction memo" for each issue.

The Results

Using IMPACT in a real situation resulted in benefits for both management and research. IMPACT was helpful in assessing issues which could be directly related to specific management activities, such as timber harvesting or ski area development. IMPACT was less helpful in assessing broad policy issues, such as how much wilderness should be maintained. It was difficult to relate the specific activities and effects which are contained in the information base to such broad policy issues.

The development of the system also benefited from this application. Because there was not time for the training and assistance we had planned, IMPACT's ease of use was thoroughly tested. With only minimal training, the resource analyst was able to use the system extensively with no additional user documentation beyond that contained in the system.

This Colorado experience indicated that the questioning and answering portions of IMPACT were essentially complete, and that future development energies could be concentrated elsewhere. The difficulties in using IMPACT for general policy issues clarified what types of problems IMPACT could and could not handle. IMPACT remains limited to those issues which can be related to specific management activities, although the information base was modi-

fied to give the system the capability of addressing somewhat more general issues. And finally, by addressing the key issues of such a large area as the eastern Rocky Mountains, priority topics for strengthening the information base–e.g., recreation and rangeland grazing–were identified.

CONCLUSIONS

IMPACT is in use, and essentially complete. Future programing changes to increase efficiency and transportability are planned, but these will be invisible to the user.

An important part of the development process was the application to real life problems *before* the system was complete. The evaluations which accompanied these applications allowed us to steer the course of development so that IMPACT meets management needs. The system is different than it would have been had we not undertaken these applications. Users are not faced with the choice of accepting or rejecting a product in the form that researchers decided they need; rather, through early applications, the system has been modified to meet user needs as users perceive them.

NOTES

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[5] During the study reported in this note, James R. Hagemeier was staff systems coordinator and Bruce Bornstein was resource analyst, Rocky Mountain Region.

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